Exercise during pregnancy reduces the rate of cesarean section: results of a randomized controlled trial.

Journal:	*The Journal of Maternal-Fetal & Neonatal Medicine*
Manuscript ID:	DJMF-2011-0799
Manuscript Type:	Original Paper
Date Submitted by the Author:	22-Nov-2011
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Keywords:	Delivery, Gestation, Physical activity, Outcome, Labor

Title Page

Exercise during pregnancy reduces the rate of cesarean section: results of a randomized controlled trial

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Keywords: Delivery; Gestation; Labor; Outcome; Physical Activity

ABSTRACT

Objective:

In this study, the authors assessed the effects of a structured, moderate-intensity exercise program during the entire length of pregnancy on a woman's method of delivery.

Methods:

A randomized controlled trial was conducted with 290 healthy pregnant Caucasian (Spanish) women with a singleton gestation who were randomly assigned to either an exercise (*n*=138) or a control (*n*=152) group. Pregnancy outcomes, including the type of delivery, were measured at the end of the pregnancy.

Results:

The percentage of cesarean and instrumental deliveries in the exercise group were lower than in the control group (15.9%, n=22; 11.6%, n=16 vs. 23%, n=35; 19.1%, n=29, respectively; *p*=0.03). The overall health status of the newborn as well as other pregnancy outcomes were unaffected.

Conclusions:

Based on these results, a supervised program of moderate-intensity exercise performed throughout pregnancy was associated with a reduction in the rate of cesarean sections and can be recommended for healthy women in pregnancy.

INTRODUCTION

Pregnancy is a unique process in which nearly all of the body's control systems are modified to maintain both maternal and fetal homeostasis [1]. With physical exercise (PE) becoming an integral part of many women's lives, the question remains as to whether this exercise has any adverse effects on pregnancy outcomes [2]. In theory, the addition of PE may represent a significant challenge to both the maternal and fetal wellbeing as the dual stresses of pregnancy and exercise may create conflicting physiological demands and thus adversely affect pregnancy outcomes [3].

Research on exercise in pregnancy has increased over the years, and many studies have demonstrated the benefits of PE on maternal and fetal outcomes [4, 5], including positive maternal psychological factors [6, 7] and decreased risks of preeclampsia and gestational diabetes (GD) [8, 9].

Despite the advancement of knowledge on exercise during pregnancy, a general lack of consensus persists regarding the effect of PE on the type of delivery. Scientific evidence from experimental studies on the influence of exercise on the type of delivery is limited and imprecise [10]. Because most studies were observational (with no intervention) and focused on leisure time and occupational physical activity, little information is available about the effects of a supervised exercise program throughout pregnancy on the type of delivery.

Since 2000, the worldwide rate of cesarean delivery has risen even more sharply and is currently over 31 percent. This rate is concerning from a public health perspective because the procedure is not without risk to the mother and fetus [10]. Known risks of cesarean sections include the following: maternal postnatal complications stemming from major abdominal surgery, placental problems in future pregnancies, neonatal respiratory difficulties, poor sucking reflex in the newborn, infection, excessive blood loss, maternal respiratory complications, anesthesia reactions and longer hospitalizations [13,14].

The aim of the present study was to understand the influence of an exercise program during pregnancy (all three trimesters) on the type of delivery that ultimately occurred. A secondary objective was to determine if exercise could be a protective factor against cesarean sections or instrumental delivery methods in women who experienced excessive weight gain during pregnancy. We hypothesized that regular exercise during pregnancy would be associated with a lower percentage of cesarean sections in normal pregnancy and lower cases of instrumental deliveries and cesarean sections in pregnant women with excessive weight gain.

METHODS

The present study was a randomized controlled clinical trial (RCT) in accordance with the recently published CONSORT guidelines (http://www.consort-statement.org) [15]. The study also met the ethical standards in Sport and Exercise Science Research [16].

The research protocol was reviewed and approved by the Ethical Committee of Hospital Universitario de Fuenlabrada (Madrid, Spain) and followed the ethical guidelines outlined in the Declaration of Helsinki (last modified in 2008). The research was performed in the obstetrics department of the Hospital. All participants were informed about the aim and study protocol, and written informed consents were obtained from all participating women.

Study subjects:

Participants were recruited from a hospital database. All the women were healthy with uncomplicated and singleton pregnancies. To allocate participants, a computer-generated list of random numbers was used. The randomization process (sequence generation, allocation concealment and implementation) was conducted for three different study investigators.

Patients were excluded if they had any type of absolute obstetrical contraindication to exercise regarded by the American College of Obstetricians and Gynecologists (ACOG) (e.g. multiple pregnancies or risk for premature labor) [17]. Other exclusion criteria included those women not planning to give birth in the obstetrics department of the study hospital, not receiving medical follow-up throughout the pregnancy, participating in another physical activity program or having a high level of pregestational PE (four or more times per week).

Intervention:

The physical conditioning program included a total of three 40-45 minute sessions per week, beginning at the start of the pregnancy (weeks 6–9) until the end of the third trimester (weeks 38–39). Thus, there was an average of 85 training sessions planned for each participant in the absence of preterm delivery. All subjects used a heart rate (HR) monitor (Accurex Plus, Polar Electro OY, Oulu, Finland) during the training sessions to ensure that exercise intensity was light to moderate. Their HR was consistently kept under 70% of their age-predicted maximum HR value, calculated as 220 minus age.

Each session included a 25-minute core portion that was preceded and followed by a gradual warm-up and cool-down period, both of 7–8 minutes in duration and consisting of walking and light, static stretching (to avoid any muscle pains) of most muscle groups (upper and lower limbs, neck and trunk muscles).

We used exercises covering the major muscle group in the arms and abdomen to promote good posture, prevent lower back pain and strengthen the muscles of labor and the pelvic floor. We also included an aerobic dance section in every session. Exercises involving the Valsalva maneuver, extreme stretching, joint overextension, ballistic movements and jumping were specifically avoided. Furthermore, exercises in the supine position were performed for no longer than two minutes.

Methods

In order to maximize safety, adherence to the training program and its efficacy, all sessions were i) supervised by a qualified fitness specialist (working with groups of 10–12 subjects) with an obstetrician's assistance; ii) accompanied by music; and iii) performed in the Health Care Center in a spacious, well-lit room under favorable environmental conditions (altitude 600 m; temperature=19–21ºC; humidity=50–60%). An adequate intake of calories and nutrients was assured before the start of the exercise session.

Measurement of Variables:

We obtained the type of delivery (normal, instrumental, or cesarean) and pregnancy outcomes from hospital perinatal records including gestational age (days), preterm deliveries (before the completion of 37 weeks gestation), maternal weight gain (kg), blood pressure, one hour oral glucose tolerance test, cases of GD, birth weight/length, pH of the umbilical cord blood and Apgar score.

The following maternal characteristics were obtained by an initial interview at the first prenatal visit: maternal age, parity, smoking habits during pregnancy, occupational activity, time standing per day, time spent on domestic activities and educational level.

We measured weight and height of the mother by standard procedures at the start of the study. Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared. Adherence (attendance) to the training program was measured using a checklist at every session.

Data analysis:

Our data (presented in Tables I and II) were analyzed using Student's t-tests for independent samples, one-way ANOVA and $\chi2$ tests.

Maternal characteristics of the study sample by group (EG and CG) were reported in terms of means and standard deviation (SD), unless otherwise stated. Relative to frequencies, $\chi2$ tests were used. For group comparisons of pregnancy outcomes, continuous and nominal data were analyzed with t-tests for unpaired data and $\chi2$ tests, respectively. To estimate the effect size, relative risk and 95% confidence intervals for the difference were calculated.

An interim analysis was conducted to assure the safety of the intervention during the trial (n=60). The levels of significance maintained an overall *p*-value of 0.05 and were calculated according to the O'Brien-Fleming stopping boundaries [18].

Determination of sample size: To detect a 10% reduction in cesarean sections with a two-sided 5% significance level and a power of 80%, a sample size of 125 pregnant per group was necessary, given an anticipated dropout rate of 15% [19].

Statistical analysis was performed using the Statistical Package for Social Sciences software (version 14.0 for Windows; SPSS Inc., Chicago, IL) with the level of statistical significance set to <0.05.

RESULTS

Out of the 595 women originally contacted at their first prenatal visit, 320 Caucasian, healthy gravid women (aged 31 (SD=4) years) were randomly assigned to either an exercise group (EG, n=160) or a control group (CG, n=160). Of these women, 290 belonged to a low-to-medium socioeconomic class.

A flow diagram of the randomization process of the study participants is shown in Figure 1. Fourteen percent (22/160) and 5% (8/160) of pregnant women in the EG and CG, respectively, were lost to follow-up. We excluded twenty-two women in the EG for the following reasons: discontinued intervention (n=8), risk for premature labor (n=3), pregnancy-induced hypertension (n=2) and personal reasons, such as change of residence or work-related issues (n=9). Eight women were excluded in the CG for pregnancy-induced hypertension (n=2), threat of premature delivery (n=3) and personal reasons (n=3).

Adherence to training and possible adverse effects:

Adherence to the training program in the EG was 87%. In the EG, 138 pregnant completed the program with a high level of satisfaction. Because participating in another exercise program was an exclusion criterion for the CG, this was verified via telephone interview at week 20 and at the end of pregnancy. In the end, 138 women in the EG and 152 women in the CG were included in the analysis.

Figure 1: Flow diagram of the study participants following the CONSORT guidelines (http://www.consortstatement.org).

Results

Maternal characteristics: Background variables of the study populations are shown in Table 1. There were no significant differences (p>0.05) in background variables between the two study groups; these background variables included maternal age, BMI, parity, previous preterm delivery, previous miscarriages and previous low birth weight. Maternal characteristics that could be potentially influence the main study outcome (e.g., occupational activity, educational level, smoking during pregnancy, standing and housework) were also not significantly different between the groups.

Table I: Maternal Characteristics: comparison between control and intervention groups.

Type of delivery and other pregnancy outcomes:

We observed that the percentage of cesarean sections (15.9%, n=22) and instrumental deliveries (11.6%, n=16) in the EG was lower than those in the CG (23%, n=35; 19.1%, n=29, respectively; Z=2.73; p= 0.03; $1-_{\beta}$=0.65). We observed a reduced Relative Risk (RR) of cesarean section for women in the EG compared with the CG (0.47, 95% CI= 0.26, 0.82). Nine women delivered before term in the EG (6.5%) and 10 (6.6%) in the CG. The mean gestational age was similar in both groups (EG=278.0 (SD=9.9), CG=278.3 (SD=10.3) days).

When other pregnancy outcomes were examined, we found similar results between groups for Oral Glucose Tolerance Test, GD and mean blood pressure during pregnancy. Maternal weight gain was lower in the EG (11.9 (SD=3.7) kg) compared to the CG (13.7 (SD=4.1) Kg) (p= 0.0001). We observed no differences between the groups in the newborn's overall health status, including Apgar scores at one and five minutes, birth weight, birth length and the pH of umbilical cord blood.

Table II: Type of delivery and other pregnancy outcomes: comparison between control and intervention groups.

An additional analysis was conducted to compare the types of deliveries between groups of pregnant women with excessive weight gain. There was a lower rate of cesarean sections in the EG (16.1%, n=5) compared to the CG (39.7%, n=27), although the difference was not statistically significant.

DISCUSSION

This study is the first randomized controlled trial that specifically and objectively shows a positive association between the type of delivery and supervised, regular exercise when performed by a large sample of previously sedentary, gravid women throughout the duration of their entire pregnancy. An additional novel intervention of our study was the integration of light resistance, toning, aerobic dance and pelvic floor exercises in the training program, which is not commonly available to pregnant women.

We examined the influence of PE on the delivery method, providing an opportunity to determine the possible influence of a physical activity program during pregnancy (during all three trimesters) on the type of delivery.

The main finding of our study was that supervised resistance training is associated with a lower percentage of cesarean and instrumental deliveries. These findings have clinical relevance given that the cesarean rate is a public health concern because the procedure is not without risks and can adversely affect perinatal outcomes [10, 14].

The overall health status of the baby was unaffected with exercise, as reflected and reinforced by the results of the globally used Apgar score. Moreover, some pregnancy outcomes (e.g., maternal weight gain) improved in the EG, which could explain the protective effect of PE against pregnancy complications.

In additional analyses, our results show a lower percentage of cesarean sections in women with excessive weight gain in the EG. In concordance, many researchers have found that normal maternal BMI and appropriate weight gain during pregnancy is strongly related to the ability of pregnant women to delivery vaginally without difficulty [20-22].

In the past, studies on the influence of leisure-time physical activity on the type of delivery have generated mixed results. Most of these studies refer to the relationship between occupational activity or working conditions and pregnancy outcomes, though few clinical trials existed.

Our results are in agreement with other study findings. In an experimental study, Clapp found that women who continue to exercise during pregnancy compared with sedentary pregnant women had a lower incidence of cesarean sections (6 %, n=5 vs. 30%, n= 13) and instrumental deliveries (6 %, n= 5 vs. 20%, n= 9) [17]. Recently, in an observation study, Melzer et al. measured energy expenditure, aerobic fitness and sleeping HR in 44 healthy women in late pregnancy and found that the risk for operative delivery was lower in active women compared with those that were inactive (odds ratio of 3.7) [23].

Bungun et al., by a non-experimental, retrospective study, assessed the association between participation in aerobic exercise during the first two trimesters of pregnancy and type of delivery in 137 nulliparous women. They found that sedentary women (n=93) were 2.05 times more likely to deliver via cesarean section than active women (n=44), though this difference was not statistically significant [13].

A notable group of studies found no influence of physical activity on the type of delivery (5, 24-26). In a recent study, Bø et al. found that exercising at least three times per week was not associated with vacuum or forceps deliveries or acute cesarean deliveries [11].

Discussion

In a randomized controlled trial, Cavalcante et al. studied 71 low-risk sedentary pregnant women to evaluate the effectiveness and safety of water aerobics during pregnancy (activity was initiated at 18-20 weeks). They found no difference in the type of delivery between study groups; however, most of the deliveries in the intervention group were normal vaginal deliveries [27].

Bovbjerg and Siega-Riz, by a Pregnancy Risk Assessment Monitoring System, collected data (via questionnaire) on the frequency of exercise during the last three months of pregnancy in 1955 women. They found that exercise was not associated with delivery method [10].

In contrast with these investigations, a few studies suggest that exercise during pregnancy may have a negative impact on the type of delivery. Dale, in a study with 33 runners and 11 controls, reported a trend noticed in runners; this group tended to fail to progress in labor and delivery, and thus resulted in cesarean sections [12].

In a prospective study to evaluate the influence of employment and physical exertion on pregnancy outcomes (quantified by kilocalories expended each day), Magann et al. found an increased proportion of nonelective cesarean sections for women in the higher energy expenditure group (>3000 kcal/day) [28].

The differences in our results compared to those of other studies can be attributed to the variety of study design, type and intensity of the exercise and duration of the programs used by other studies. In our previous study [5], we observed no influence of exercise on the type of delivery in an RCT performed only during the second and third trimesters of pregnancy. Also, other experimental studies [11, 27] start physical activity programs around 18-20 weeks of gestation, which could be an important factor in the difference with the results of the present study. In addition, many observational studies derive their results from the information from pregnant women [10, 23, 25] or only by the comparison between groups of different exercise intensities [24]. Moreover, studies that found physical exertion (runners, high workload) was associated with abdominal deliveries [12, 28] could demonstrate that exercise during pregnancy should be limited to moderate intensity.

We observe that different studies, usually testing a small sample or based on observational designs, have given inconsistent results and conclusions. The main contribution of this study is evidence that regular exercise can coexist with pregnancy and have positive effects on the type of delivery.

In summary, our findings encourage the growing trend in healthy, pregnant women to join a physical activity program. This study suggests that light-to-moderate exercise can result in improved clinical outcomes for the mother and newborn and serve to be an important contribution to public health.

Acknowledgements

The authors would like to acknowledge the technical assistance of the Gynaecology and Obstetric Service of Fuenlabrada Hospital of Madrid. This work was partially supported by the Ministerio de Ciencia e Innovación, Spain (DEP2009-08990).

DECLARATION OF INTEREST

The authors report no Competing of Interest.

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Tables and Figures

TABLES AND FIGURES

TABLE I: Maternal Characteristics: Comparison Between Control and Exercise Groups.

		Controls (*n*=152)	**Exercise (*n*=138)**	
		Mean (SD) or n/%	**Mean (SD) or n/%**	***p*-value**
Maternal age (years)		31.7 (4.5)	31.4 (3.2)	0.54
BMI[a]		23.6 (4.0)	24.0 (4.3)	0.45
Parity	0	83/54.6	88/60.9	0.19
	1	60/39.5	46/33.3	
	>1	9/5.9	4/2.9	
Occupational Activity	Active	51/33.6	55/39.9	0.50
	Sedentary	68/44.7	58/42	
	Housewives	33/21.7	25/18.1	
Educational level	College	45/29.6	29/21	0.23
	High school	67/44.1	70/50.7	
	<High school	40/26.3	39/28.3	
Smoked during pregnancy	Yes	29/19.1	18/13	0.16
	No	123/80.9	120/87	
Standing Hours/day	>3 h/day	95/62.5	92/66.7	0.45
	3 or <3 h/day	57/37.5	46/33.3	
Previous Preterm Deliveries	0	146/96.1	130/94.2	0.46
	1 or >1	6/3.9	8/5.8	
Previous Miscarriages	0	104/68.4	107/77.5	0.20
	1	42/27.6	28/20.3	
	>1	6/3.9	3/2.2	
Previous Low Birth Weight Deliveries	0	147/96.7	135/97.8	0.56
	1 or >1	5/3.3	3/2.2	
Housework Hours/day	>2 h/day	81/53.3	83/60.1	0.24
	2 or <2 h/day	71/45.5	55/39.9	

[a]BMI at first prenatal medical visit.

TABLE II: Type of Delivery and Other Pregnancy Outcomes—Comparison between Control and Exercise Groups.

		Controls (*n*=152) Mean (SD) or *n*/%	Exercise (*n*=138) Mean (SD) or *n*/%	*p*-value
Type of delivery	Normal	88/57.9	100/72.5	*0.03 χ2 = 6.8
	Instrumental	29/19.1	16/11.6	Z=2.73 RR=0.47
	Cesarean	35/23	22/15.9	(0.26, 0.82)
Preterm delivery		10/6.6	9/6.5	0.98
Maternal weight gain (kg)		13.7 (4.1)	11.9 (3.7)	*0.0001 **d= 0.56
Gestational age (days)		278.0 (10.3)	278.3 (9.9)	0.81
Apgar Score 1 min.		8.6 (1.3)	8.7 (1.4)	0.34
Apgar Score 5 min.		9.8 (0.8)	9.7 (0.6)	0.22
Birth Weight (g)		3232 (448)	3203 (461)	0.56
Birth Length (cm)		49.5 (2.07)	49.7 (2.06)	0.98
pH Umbilical Cord.		7.26 (0.07)	7.28 (0.08)	0.29
Oral Glucose Tolerance Test (g/dL).		119.2 (28.5)	117.2 (30.7)	0.59
Gestational Diabetes	Yes	12/7.9	6/4.3	0.21
	No	140/92.1	132/95.7	
Blood Pressure[a]	Diastolic	70.8 ± 8.5	69.6 ± 9.6	0.29
	Systolic	115.6 ± 11.7	113.8 ± 15.1	0.25
EWGDP***		Controls (n= 53)	Exercise (n= 31)	
Type of delivery (n/%)	Normal	25/47.2	22/71	
	Instrumental	8/15.1	4/12.9	0.07
	Cesarean	20/37.7	5/16.1	

*Significant level at p=0.05
** Cohen´s *d*
*** Excessive Weight Gain During Pregnancy
[a]Mean during pregnancy.

Tables and Figures

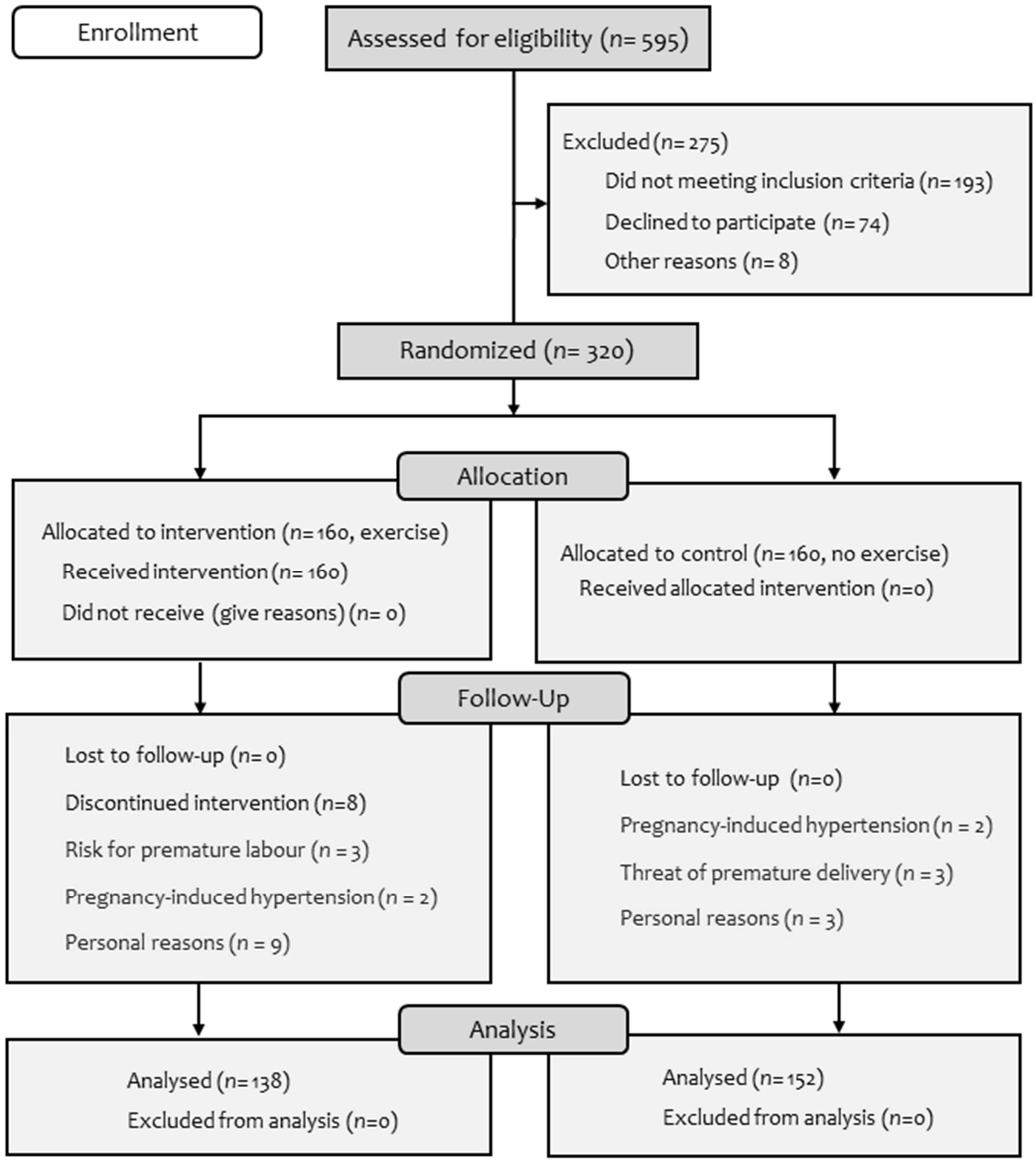

Figure 1. Flow chart of the study participants